Forest Practices Technical Note Number 2

Version 2.0

High Landslide Hazard Locations, Shallow, Rapidly Moving Landslides and Public Safety: Screening and Practices

Effective January 1, 2003

Edited January 24, 2019 to recognize updated rule references

Objective

Technical notes are written to help resource professionals, in this case, foresters or engineers responsible for planning harvest operations or road construction on steep slopes. This technical note is designed to help forest practices foresters, landowners, and operators screen forestlands prior to harvesting or road construction to identify locations subject to the Shallow, Rapidly Moving Landslides and Public Safety Rules (OAR 629-623-0000 through 0800). For operations identified by this screening process, Forest Practices Technical Note 6: *Determination of Rapidly Moving Landslide Impact Rating* may be used to determine public safety restrictions.

Background

Senate Bill 12 (1999) directed the Board of Forestry to adopt rules to replace a temporary prohibition of certain operations authorized by Senate Bill 1211 in 1997. The Shallow, Rapidly Moving Landslides and Public Safety rules are effective January 1, 2003. **This guidance supercedes *Version 1.0* of this note (from October 18, 2000).** This guidance is intended to apply to shallow, rapidly moving landslides, and should be applied with caution when evaluating the public safety risk associated with road fill failures, waste area failures, or deep seated landslides.

Initial screening of operations

The initial screen determines if there may be high landslide hazard locations within the operation area **and** if there may be structures or roads in the path of a potential shallow, rapidly moving landslide below the operation area (Figure 1).

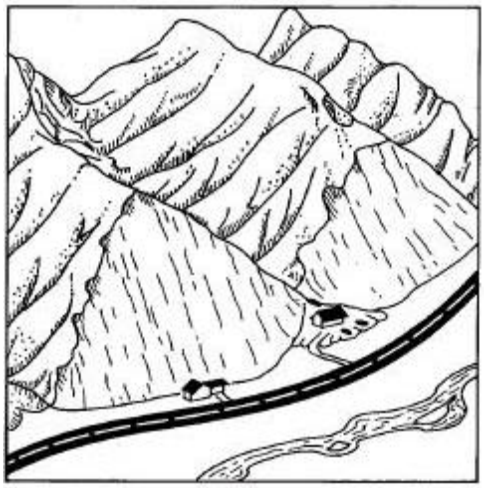

Figure 1. Homes and road in debris flow-prone locations (on a debris fan at the base of a debris torrent prone channel and at the base of a uniform steep slope).

The Oregon Department of Forestry will conduct the initial screen to determine if the shallow, rapidly moving landslides and public safety rules might apply to an operation. The results of the initial screen determine if further investigation is needed. Further investigation is needed (see pages 4-8 of this document) if both of the two following conditions exist:

1. There may be ***high landslide hazard locations*** within the proposed operation area, based on map-estimated slope steepness or other information;
2. There may be structures or public roads downslope from the proposed operation area that could be impacted from a shallow, rapidly moving landslide initiating within the operation area.

Figure 1 illustrates the typical conditions that should be identified by this screening process.

Slope steepness

The initial screen for slope steepness should use USGS 1:24,000 topographic maps, a ten-meter digital elevation model (DEM) based on these maps, or more accurate slope steepness information. Because USGS maps tend to underestimate actual slope steepness, map- or ten-meter DEM-determined slopes steeper than 65 percent for most of western Oregon, and 60 percent in the ***Tyee Core Area*** (described later in this Technical Note) are considered likely to have high landslide hazard locations in the field. Thirty-meter DEMs should not be used for screening, since they are very inaccurate.

Structures and public roads

Shallow, rapidly moving landslides move down steep hillslopes and confined stream channels. They can move long distances, over a mile in some cases, especially if they enter a confined stream channel. If there may be structures or public roads in canyons, near the mouths of canyons, or close to the base of steep slopes below the operation, then additional on-the-ground investigation is needed.

Terminology

A ***debris fan*** is a deposit formed when a debris flow comes to rest. Fans are typically composed of poorly sorted boulders in soil and may also include woody material.

A ***debris flow*** is a highly mobile slurry of rock, soil, wood, and water that can travel hundreds to thousands of feet on steep slopes or in steep channels. There are two types of debris flows: open-slope debris flows and debris torrents. Debris flows are shallow, rapidly moving landslides.

A ***debris torrent*** is a debris flow confined within a channel or draw. They often scour the channel to bedrock, increasing in size as they travel hundreds or thousands of feet beyond the site of initial failure, delivering significant volumes of material to their deposition area.

Exposure categories [629-600-0100(21)] are used to designate the likelihood of persons being present in structures or on public roads during periods when shallow, rapidly moving landslides may occur.

A ***further review area [629-600-0100(29)]*** is an area that may be subject to rapidly moving landslides. It includes high landslide hazard locations, as well as certain slopes and channels below high landslide hazard locations. Occupied buildings or paved public roads in further review areas may be at risk from shallow, rapidly moving landslides.

Headwalls are obviously concave-shaped slopes (as seen along the slope contour on the ground surface) that can concentrate water to increase landslide susceptibility. Landslides occurring in these locations are also more likely to move as channelized debris flows than landslides that initiate in other areas of the slope.

A ***high landslide hazard location [629-600-0100(31)]*** is a specific site that is subject to initiation of a shallow, rapidly moving landslide. Criteria for identification of high landslide hazard locations are described later in this note.

An ***open-slope debris flow*** is a debris flow that does not enter a confined channel or unchannelized draw. They travel tens to hundreds of feet from the initiating high landslide hazard location.

A ***shallow, rapidly moving landslide [629-600-0100(61)]*** means any detached mass of soil, rock, or debris that begins as a relatively small landslide on steep slopes and grows to a sufficient size to cause damage as it moves down a slope or stream channel at a velocity difficult for people to outrun or escape.

The ***Tyee Core Area [629-600-0100(74)]*** is defined as “a location with geologic conditions including thick sandstone beds with few fractures. These sandstones weather rapidly and concentrate water in shallow soils creating a higher shallow, rapidly moving landslide hazard. The Tyee Core area is located within coastal watersheds from the Siuslaw watershed south to and including the Coquille watershed, and that portion of the Umpqua watershed north of Highway 42 and west of Interstate 5. Within these boundaries (as shown in Figure 2), locations where the bedrock is highly fractured or not of sedimentary origin, as determined in the field by a geotechnical specialist, are not subject to the Tyee Core area slope steepness thresholds.” See Figure 2.

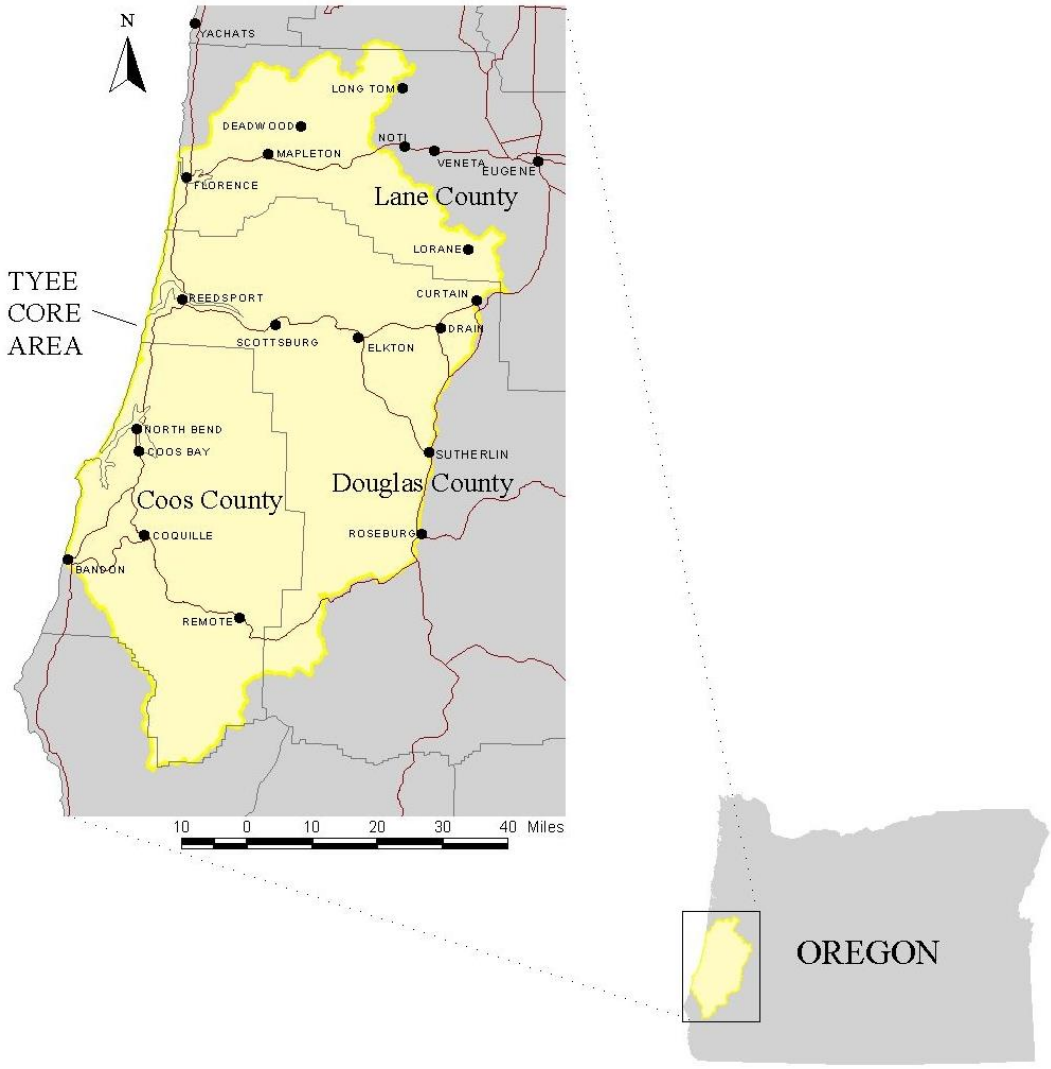

Figure 2. Location of the Tyee Core Area.

Overview of steps for determining necessary forest practices

For operations that meet the initial screen described earlier, further investigation using the five following steps is needed to determine if the operation is subject to the shallow, rapidly moving landslides and public safety rules, and to determine the required forest practices. Note that all operations containing high landslide hazard locations are subject to the rules for natural resource protection, regardless of whether the public safety rules also apply.

Step 1 - Determine the ***further review area*** for the operation. The further review area begins at high landslide hazard locations within the operation **and** continues down the channel or slope below the operation until that channel or slope cannot transport a shallow, rapidly moving landslide.

Part A - Identifying ***High Landslide Hazard Locations***

Part B - Identifying downslope extent of the ***Further Review Area***

Step 2 - Verify if there are structures or public roads below the operation area and in the further review area. If so, determine the ***Exposure Category*** for these structures or roads. If not, then the landslide and public safety rules do not apply. Apply natural resource forest practices rules.

Step 3 - Determine Rapidly Moving Landslide Impact Rating as ***extreme***, ***serious***, ***moderate***, or ***unlikely***.

Step 4 - Downslope Public Safety Risk is determined as ***Substantial, Intermediate, or Low***.

Step 5 - Harvesting and road building practices are regulated based on the Downslope Public Safety Risk Level determination.

STEP 1: DETERMINE THE FURTHER REVIEW AREA FOR THE OPERATION

Part A - Identifying High Landslide Hazard Locations

Are there any high landslide hazard locations present within the proposed harvest unit or along the proposed road [629-623-0100(1)]?

A ***high landslide hazard location*** is a slope with characteristics (steepness, shape, and geology) that make it subject to shallow, rapidly moving landslides. Other landslides that are large and typically move more slowly, such as slumps and earthflows, are not *shallow, rapidly moving landslides*. A *shallow, rapidly moving landslide* begins as a relatively small landslide and moves at a velocity that is difficult for persons to outrun or escape. Note that high landslide hazard location identification is based on physical slope characteristics and is independent of proposed harvesting or road building practices.

High landslide hazard locations are specific sites that are subject to initiation of shallow, rapidly moving landslides. The specific criteria for determination of these sites is found in 629-623-0100 (3) as:

(a) The presence, as measured on site, of any slope in western Oregon (excluding competent rock outcrops) steeper than 80 percent, except in the Tyee Core Area, where it is any slope steeper than 75 percent; or

(b) The presence, as measured on site, of any headwall or draw in western Oregon steeper than 70 percent, except in the Tyee Core Area, where it is any headwall or draw steeper than 65 percent.

(c) Notwithstanding the slopes specified in (a) or (b) above, field identification of atypical conditions by a geotechnical specialist may be used to develop site specific slope steepness thresholds for any part of the state where the hazard is equivalent to (a) or (b) above.

Field Measurements: High landslide hazard locations are determined based on measurements of the steepest slopes on-the-ground. These field measurements may find slope conditions different from the initial screen, and take precedence over the screen. Short pitches of steep slopes that are less than 30 feet slope length in otherwise relatively gentle terrain are not considered high landslide hazard locations. Constructed cutslopes are not considered high landslide hazard locations, but sidecast and other fillslopes are. Remember that clinometers do not give precise slope readings, so when slopes just under threshold criteria are measured with a clinometer, they may in fact be high landslide hazard locations.

Part B - Identifying downslope extent of the Further Review Area

Does the channel or slope have characteristics which are conducive to open-slope debris flow or debris torrent transport or deposition (part of the further review area)?

Open-slope debris flows typically slow down or stop when they encounter unconfined and relatively gentle slopes (wide valleys or benches). Debris torrents usually stop when they enter unconfined channels, low gradient stretches of channels, or debris fans.

For debris torrents, the further review area is 100 feet on each side of a confined channel. The further review area ends after any of the following conditions are encountered:

1. The average channel gradient becomes 6% or less for at least 300 feet.
2. The canyon width exceeds 200 feet or more for a distance of at least 300 feet. The width is generally measured at a height of 10 feet above the channel bottom.
3. The channel loses confinement (such as at the mouth of a canyon). The further review area extends 200 feet from the point where the channel loses confinement.

However, regardless of conditions described above, if there is field evidence of a *debris fan* at the mouth of the channel, the further review area continues to the lower edge of the debris fan.

For ***open-slope debris flows***, the further review area ends 100 feet downslope after slope gradient drops to and remains below 40 percent.

STEP 2: ARE THERE STRUCTURES OR PUBLIC ROADS IN THE FURTHER REVIEW AREA? IF SO, DETERMINE THE EXPOSURE CATEGORY.

On the ground, carefully look for structures or roads. Obtain permission from other landowners as needed. If these structures or public roads are within the further review area, determine the Exposure Category for the operation.

Exposure Categories are used to designate the likelihood of persons being present in structures or on public roads during periods when shallow, rapidly moving landslides may occur. When there are high landslide hazard locations within a proposed timber harvesting area or along a proposed road, operators must identify structures and paved public roads that might be at risk from rapidly moving landslides initiating within the operation area [629-623-0100(2)]. There

are three exposure categories that can trigger the shallow, rapidly moving landslides and public safety rules, as described in OAR 629-623-0200(2)-(4).

Exposure Category A includes habitable residences, schools, and other buildings where people are normally present during periods when wet season rainstorms are common.

Exposure Category B includes paved public roads averaging over 500 vehicles per day, as determined, if possible, during periods when wet season rainstorms are common.

Exposure Category C includes barns, outbuildings, recreational dwellings not included in Exposure Category A, low-use public roads, and other constructed facilities where people are not usually present when wet season rainstorms are common.

Periods when wet season rainstorms are common generally means November 1 through April 30. If the building is occupied during the winter, it is Exposure Category A. If a building is occupied mostly in the summer, it is Exposure Category C. Outbuildings, such as barns or detached garages, are not normally considered to be occupied buildings and are typically in Exposure Category C.

Evaluating traffic volume: The Oregon Department of Transportation has traffic volume data for state highways. In addition, many counties also have traffic use data available. Landowners may be able to conduct their own traffic counts, using standard traffic count methods. In the absence of traffic count data, double-lane, paved county and state roads are considered to be high traffic volume roads.

Special circumstances: Certain structures in the path of rapidly moving landslide that might fail upon impact and injure persons in structures or on roads further downstream are also considered by the rules. OAR 629-623-0250 (4) states that "the impact rating may include the potential for the failure of a structure in the direct path of a rapidly moving landslide resulting in a substantial risk of serious bodily injury or death to the exposed population below that structure". Such structures can include certain dams, power transmission towers, and industrial fuel tanks. An impact rating should also be conducted for these structures, as described in Technical Note 6.

STEP 3: DETERMINE THE IMPACT RATING.

Impact Ratings: OAR 629-623-0250(3) allows the State Forester to require the landowner to submit a geotechnical determination of shallow, rapidly moving landslide impact rating. A geotechnical determination of impact rating may be required for any structures or roads meeting Exposure Categories A, B, and in some special cases C, within the further review area below the operation. Landowners should consult with ODF before enlisting the services of a geotechnical specialist.

A geotechnical specialist, normally a licensed geotechnical engineer or engineering geologist, may conduct the geotechnical determination of rapidly moving landslide impact rating. Forest Practices Technical Note Number 6, *Determination of Rapidly Moving Landslide Impact Rating,*

has been designed for these geotechnical determinations. After the operator has submitted the geotechnical report, the State Forester will review the final impact rating based on information provided in the geotechnical report. The State Forester has the final determination of the impact rating [629-623-0250(5)].

The impact rating identifies the relative risk of rapidly moving landslide impact to structures or roads where there may be a risk of serious bodily injury or death. The impact rating reflects the frequency and expected severity of impact from a rapidly moving landslide initiating within a forest operation impacting any specific structure or road. Property damage alone is not considered in determination of impact rating.

Rapidly moving landslide impact potential is rated as ***unlikely, moderate, serious*** and, in limited cases, ***extreme*** (OAR 629-623-0250(2)).

Rapidly moving landslide impact rating definitions:

- **"Unlikely"** impact rating indicates that any shallow, rapidly moving landslide initiating within the operation area is unlikely to reach the structure or road.
- **"Moderate"** impact rating indicates that any shallow, rapidly moving landslide initiating within the operation area is likely to stop prior to the structure or road, or will not directly impact the structure or road. However, a moderate rating also indicates that dangerous impacts cannot be reasonably ruled out.
- **"Serious"** impact rating indicates that any shallow, rapidly moving landslide initiating within the operation area is likely to directly impact a structure or road.
- **"Extreme"** impact rating indicates that any shallow, rapidly moving landslide initiating within the operation area is likely to directly impact a structure or road and, in addition, there are unusual conditions that make dangerous impacts almost certain.

STEP 4: DETERMINE DOWNSLOPE PUBLIC SAFETY RISK LEVEL.

Downslope public safety risk levels are based on the exposure category (from Step 2) and the rapidly moving landslide impact rating (from Step 3). Downslope public safety risk level is characterized as either "substantial," "intermediate," or "low."

Table 1 is a matrix that shows how Exposure Category [OAR 629-600-0100(21), 0200(2)-(4)] and Rapidly Moving Landslide Impact Rating [OAR 629-623-0250(1), (2)] are used to determine Public Safety Risk Level [OAR 629-623-0300(1)].

Table 1. Downslope Public Safety Risk Levels

Exposure Category	Rapidly Moving Landslide Impact Rating			
	EXTREME	***SERIOUS***	***MODERATE***	***UNLIKELY***
A	Substantial	Substantial	Intermediate	Low
B	Substantial *	Intermediate	Low	Low
C	Intermediate *	Low	Low	Low

* When determined by the State Forester

STEP 5: DETERMINE THE ALLOWABLE HARVESTING AND ROAD BUILDING PRACTICES.
Substantial downslope public safety risk [629-623-0400 and 629-623-0450]**:** Prohibits all timber harvest and new roads on high landslide hazard locations (with some exceptions). Removal of dead or diseased trees, or trees on sites that have already failed and trees that have blown over can be allowed. The operator must demonstrate this operation results in no increased downslope public safety risk. Slopes must be protected from increased soil disturbance during harvesting and will be rapidly reforested.

Intermediate downslope public safety risk [629-623-0500 and 629-623-0550]**:** Requires that no more than half the high landslide hazard locations on a single ownership within the basin (for debris torrents) or hillslope (for open-slope debris flows) are in the 0 to 9 year age class or with otherwise reduced canopy closure in other age classes. This can allow for limited clearcutting. Thinning or partial cutting is allowed on all of the high landslide hazard locations to the extent that a healthy canopy is maintained during and after harvest. Given the variability of stand and site conditions across the state, setting a specific target (stems per acre, canopy closure, basal area, etc.) is difficult. The trees left after harvest should have healthy crowns and be capable of responding with rapid canopy and root regrowth after thinning. One acceptable strategy is to thin from below, retaining most of the dominant and co-dominant trees. The final density after thinning should be no lower than 30% of the maximum stand density index, with an increase in average tree diameter. This strategy, or any other thinning regime than recovers crown closure in ten years or less is acceptable.

Note that high-grading, selecting the largest trees for removal, will not result in rapid canopy closure, and is not an acceptable intermediate public safety risk practice. The long-term target is full evergreen canopy cover as a surrogate for winter water storage and fine root mass. Proposed silvicultural prescriptions in the required written plan will be evaluated in terms of their abilities to achieve that target. Thinning or partial cutting of predominately hardwood stands, unless it is done to encourage conifer growth or regrowth, is generally not considered an acceptable silvicultural practice for maintaining or enhancing canopy cover. Road construction operations require the operator to address in the written plan an evaluation of cutslope stability and other measures to prevent water from draining onto high landslide hazard locations. Generally, this will require operator-provided geotechnical specialist involvement.

Low downslope public safety risk [629-630-0500]**:** Harvesting and road building operations are not subject to restrictions for landslides and public safety. Natural resource protection rules apply to these operations, and also to any harvesting that might be allowed if there is Intermediate or Substantial Downslope Public Safety Risk. When harvesting on **any** high landslide hazard locations, operators must not construct skid roads or use ground-based equipment on these sites, and must ensure that log falling and yarding operations do not result in extensive disturbance or gouging.

Windthrow Considerations

Operators should be aware that windthrow may be a factor contributing to shallow, rapidly moving landslides. The operator should consider the wind firmness of trees that are to be left

on high landslide hazard locations and will likely need to leave additional trees outside the boundaries of the unharvested area to reduce windthrow hazard to retained trees. Crown and bole characteristics, exposure to prevailing storm winds, topographic effects, relative height of trees, and species mix (conifer/hardwood) should be evaluated when determining harvest unit boundaries when high landslide hazard locations are present. Removal of trees that can impact structures or roads can be allowed if the risk to these homes or roads from windthrow is greater than the risk from shallow, rapidly moving landslides.

Administration of the Shallow, Rapidly Moving Landslides and Public Safety Rules

The Department of Forestry will evaluate Notifications of Operations for applicability of the Shallow, Rapidly Moving Landslides and Public Safety Rules. Operators will be informed if there may be high landslide hazard locations within the operation area. It is the operators' responsibility to then use this technical note to confirm the high landslide hazard locations, and to identify the presence of structures and paved public roads within the further review area. It is also the operators' responsibility to obtain geotechnical services for determination of the Impact Rating for the operation. After the operator has submitted the geotechnical report, the State Forester will review the final impact rating based on information provided in the geotechnical report. The State Forester has the final determination of the impact rating. Oregon Department of Forestry geotechnical specialists are available to assist forest practices foresters as needed.

Written Plan Requirements

For operations with substantial or intermediate public safety risk, the operator must submit a written plan (OAR 629-623-0700) that includes:

- A determination of public safety risk based on the impact rating for the operation;
- A map showing those portion(s) of the operation containing high landslide hazard locations;
- The location of all existing and proposed new roads crossing high landslide hazard locations;
- A detailed road design for all new or reconstructed roads crossing high landslide hazard locations;
- The location of habitable structures (Exposure Category A) and paved public roads (Exposure Category B) below the operation and within further review areas;
- Locations where timber harvesting will not occur;
- Locations where partial cutting will occur and the specific silvicultural prescription; and
- Additional information related to the operation, as requested by the State Forester.

Limitations

These criteria, and the forest practice rules that apply to other forest operations, are intended to minimize disturbances to high landslide hazard locations, but do not eliminate downslope risks. Shallow, rapidly moving landslides occur in both forested and non-forested areas alike. The shallow, rapidly moving landslide rules do not eliminate the landslide threat to downslope occupied buildings or high traffic volume roads. Less steep slopes may still be subject to a

lower landslide hazard, and there are also other types of landslides that may pose a threat to public safety.

Sources of More Detailed Technical Information

Benda, L., and T. Cundy. 1990. Predicting deposition of debris flows in mountain channels. Canadian Geotechnical Journal. Volume 27, Number 4. pp 409-417.

Mills, K. & Hinkle, J. 2001. Landslides and Public Safety: an Issue Paper prepared for the Oregon Board of Forestry. Oregon Department of Forestry.

Oregon Department of Forestry 2003. Forest Practices Technical Note Number 6; Determination of Rapidly Moving Landslide Impact Rating.

Robison, E. G., K. Mills, J. T. Paul, L. Dent, and A. Skaugset. 1999. Oregon Department of Forestry 1996 Storm Impacts Monitoring Project: Final Report. Forest Practices Technical Report #4. Oregon Department of Forestry, Salem, Oregon. 141 pp.

Oregon Department of Forestry Field Offices

For more information about the Oregon Forest Practices Act or the Forest Practice Rules, please contact your local Oregon Department of Forestry office which can be found at http://www.oregon.gov/ODF/Working/Pages/FindAForester.aspx *or the headquarters office at 2600 State Street, Salem, Oregon 97310. 503-945-7200.*